

1070 Rec'd PCT/PTO 26 FEB 2002

FORM PTO-1390 (REV. 11-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER LEN-021022	
<b>TRANSMITTAL LETTER TO THE UNITED STATES          DESIGNATED/ELECTED OFFICE (DO/EO/US)          CONCERNING A FILING UNDER 35 U.S.C. 371</b>					
INTERNATIONAL APPLICATION NO PCT/EP00/08191		INTERNATIONAL FILING DATE 8/22/2000		U.S. APPLICATION NO. (If known, see 37 CFR 1.5) <b>10/069830</b>	
				PRIORITY DATE CLAIMED 8/26/1999	
TITLE OF INVENTION    SHAFT MOUNTING					
APPLICANT(S) FOR DO/EO/US    Peter Hessling					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371. 3. <input type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371 (f)). The submission must include items (5), (6), (9) and (21) indicated below. 4. <input type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31). 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)) a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau). b. <input checked="" type="checkbox"/> has been communicated by the International Bureau. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). a. <input checked="" type="checkbox"/> is attached hereto. b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4). 7. <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)). a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau). b. <input type="checkbox"/> have been communicated by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)) 9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (unsigned) 10. <input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)). <b>Items 11 to 20 below concern document(s) or information included:</b> 11. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 13. <input checked="" type="checkbox"/> A FIRST preliminary amendment. 14. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. 15. <input checked="" type="checkbox"/> A substitute specification. 16. <input type="checkbox"/> A change of power of attorney and/or address letter. 17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825. 18. <input checked="" type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4). 19. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4). 20. <input checked="" type="checkbox"/> Other items or information: "Original English translation of Specification with markings to show change;" Abstract; Copy of the International Search Report; Return Postcard and Certificate of Mailing by Express Mail					

U.S. APPLICATION NO. (if known, see 37 CFR 1.5) <b>10/069830</b>		INTERNATIONAL APPLICATION NO. PCT/EP00/08191		ATTORNEY'S DOCKET NUMBER LEN-021022	
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21. <input checked="" type="checkbox"/> The following fees are submitted: <b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... \$1,040.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... \$890.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$740.00  International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$710.00  International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$100.00  <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>				<b>CALCULATIONS PTO USE ONLY</b>          <table style="width:100%; border-collapse: collapse;"> <tr> <td style="width:50%;"></td> <td style="width:50%; text-align: right;">\$890.00</td> </tr> <tr> <td></td> <td style="text-align: right;">\$130.00</td> </tr> </table>			\$890.00		\$130.00
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Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).									
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$					
Total claims	11 - 20 =	0	x <b>\$18.00</b>	\$0.00					
Independent claims	1 - 3 =	0	x <b>\$84.00</b>	\$0.00					
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ <b>\$280.00</b>						
<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$1,020.00					
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$1,020.00					
<b>SUBTOTAL =</b>				\$1,020.00					
Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$130.00					
<b>TOTAL NATIONAL FEE =</b>				\$1,150.00					
Fee for recording the enclosed assignment (37 CFR 1.21 (h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). <b>\$40.00</b> per property +				\$0.00					
<b>TOTAL FEES ENCLOSED =</b>				\$1,150.00					
				<b>Amount to be refunded:</b>	\$				
				<b>charged:</b>	\$				

a. ☒ A check in the amount of \$ 1,150.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-0545. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.**

SEND ALL CORRESPONDENCE TO:  
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 Chicago, IL 60607  
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SIGNATURE  
 Jody L. Factor  
 NAME  
 34157  
 REGISTRATION NUMBER

**IN THE  
UNITED STATES  
PATENT AND TRADEMARK OFFICE**

**IN RE APPLICATION OF:** Hessling

**CASE:** LEN-021022

PRELIMINARY  
AMENDMENT

**SERIAL NO.:** Not yet assigned

**FILED ON:** February 26, 2002

**FOR:** SHAFT MOUNTING

ASSISTANT COMMISSIONER  
FOR PATENTS  
Washington DC 20231

**ATTENTION OF:**  
**EXAMINER:**

Dear Sir:

If any charges or fees must be paid in connection with the following communication, they may be paid out of our Deposit Account No. 50-0545.

Please enter the foregoing preliminary amendment **PRIOR** to calculation of filing fees and substantive examination of the claims.

**FACTOR & PARTNERS, LLC**  
**1327 W. Washington Blvd., Suite 5G/H**  
**Chicago, IL 60607**  
**(312) 226-1818**  
**(312) 226-1919**

Jody L. Factor

34157

**IN THE CLAIMS CANCEL**

Please cancel claims 1-11, without prejudice.

**IN THE CLAIMS ADD**

Please add claims 12-22 as follows:

12. A pneumatic actuator comprising:
  - a housing wherein the housing includes:
    - a pneumatic cylinder having an axis;
    - at least one piston that can move inside the cylinder in the direction of the axis of the cylinder, wherein the piston, together with the cylinder delimits a working space;
    - the at least one piston including teeth which extend in the direction of the axis of the cylinder;
    - a shaft which can rotate in an axial direction whose axial direction is perpendicular to the axis of the cylinder;
    - the shaft having teeth that engage with the teeth of the at least one piston, characterized in that the piston fixes the shaft in its axial direction by means of positive engagement.
13. The pneumatic actuator according to claim 12, characterized in that the shaft has at least one peripheral groove that engages with a segment of the at least one piston running in the axial direction.
14. The pneumatic actuator according to claim 12, characterized in that the shaft has two bearing sites that form the areas where the shaft has its greatest diameter.
15. The pneumatic actuator according to claim 12, characterized in that the shaft is mounted directly in the housing at two bearing sites.

16. The pneumatic actuator according to claim 14, characterized in that the bearing sites of the shaft essentially have the same diameter.
17. The pneumatic actuator according to claim 13, characterized in that the groove is a peripherally cut groove.
18. The pneumatic actuator according to claim 12, characterized in that each of the at least one piston has a total of two segments, wherein the segments are positioned adjacent the piston teeth.
19. The pneumatic actuator according to claim 12, characterized in that the at least one piston is made of plastic.
20. The invention according to claim 14, wherein the pneumatic actuator includes a working area in the area of the bearing sites of the shaft;
  - the working area being sealed from the exterior by means of sealing rings that are placed in a groove of the shaft
21. A method to mount an actuator according to claim 14, characterized in that the shaft is inserted in the bearing sites, and then the at least one piston is engaged with the shaft.
22. The method according to claim 21, characterized in that the shaft is held in the bearing sites without additional fasteners.

### **IN THE SPECIFICATION**

Pursuant to 37 C.F.R. 1.125, please delete the present specification (all parts other than the claims) and replace it with the attached "Clean copy of Substitute Specification and of Abstract." The "Substitute" Specification contains no new matter. Pursuant to the rules, Applicant has likewise attached an "Original English translation of the Specification with markings to show changes" (as a marked up version of the Substitute Specification).

**REMARKS**

Applicant respectfully submits that no new matter was added to the new claims or Substitute Specification. Such changes were added solely for conformance with U.S. practice (i.e. removal of multiple dependencies, clarifications due to translation issues, adding an "Abstract" and identifying the application by proper headings). All such changes have been made prior to substantive U.S. Examination and not in view of any prior art.

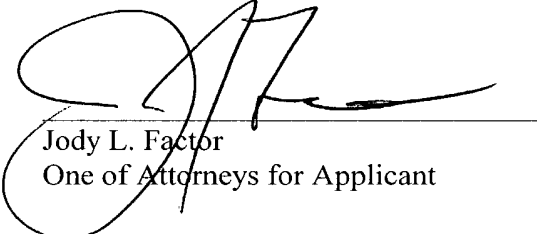
Upon entry of the foregoing, the application is in condition for substantive examination at the present time.

Should anything further be required, a telephone call to the undersigned, at (312) 226-1818, is respectfully invited.

Respectfully submitted,

FACTOR & PARTNERS, LLC

Dated: February 26, 2002



Jody L. Factor  
One of Attorneys for Applicant

## SUMMARY OF THE INVENTION

[00004] Since the invention provides that the piston fixes the shaft in its axial direction by means of a keyed fit, the shaft can move axially until the piston is inserted and hence be moved  
5 into its position without additional fasteners. As soon as the piston is inserted, the positive engagement fixes the shaft axially which is brought about in the state of the art by means of an end bracket and snap rings.

[00005] A particularly simple embodiment results when the shaft has at least one peripheral groove that engages with a segment of the piston running in an axial direction. When  
10 the shaft also has two bearing sites that form the areas where the shaft has the largest diameter, the shaft can be easily guided from the outside into the housing and fits in the area of the bearing sites. Separate bearings are essentially dispensable when the shaft is mounted directly in the housing at two bearing sites. The shaft is mounted with minimal force when the bearing sites of the shaft essentially have the same diameter and thereby eliminate pressure in both directions.

15 This also increases the length of time the shaft remains fixed at the segments and grooves.

[00006] It is particularly easy to create the groove when manufacturing the shaft when the groove is a peripherally cut groove. A symmetrical arrangement that allows the use of two identical piston results when each piston has two segments neighboring the teeth. In addition,  
20 the working area at the bearing sites of the shaft can also be sealed from the exterior by means of sealing rings made of rubber or plastic lying in a shaft groove.

[00007] A particularly advantageous method to mount the described actuator results when the shaft is first inserted into the bearing sites and then the piston(s) is engaged with the shaft so that the shaft is fixed in an axial direction without additional fasteners and, in particular, is held  
25 in the bearing sites.

## BREIF DESCRIPTION OF THE DRAWINGS

[00008] An exemplary embodiment of the present invention will be described with reference to the following drawings, wherein:

5 [00009] Fig. 1 is a cross-section of an actuator according to the present invention following the axial direction of the shaft viewed in direction of the lengthwise axis of the cylinder; and

[00010] Fig. 2 is a cross-section of an actuator following the lengthwise axis of the cylinder. The perspective coincides with the axial direction of the shaft.

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## DETAILED DESCRIPTION OF THE DRAWING

[00011] Fig. 1 illustrates a pneumatic actuator according to the invention with a housing 1, a shaft 3 mounted in the housing that rotates around an axis of 2, and two pneumatic pistons 4 and 5. The inside of the housing 1 forms a cylindrical hole 6 in which the pistons 4 and 5 are inserted to form a sealed working area. The lengthwise axis of the hole 6 is perpendicular to the plane of projection.

[00012] The shaft 3 is essentially rotational symmetrical and has the following sections from bottom to top in Fig. 1:

[00013] The bottom end of the shaft forms a bearing area 10 that also represents the site where the shaft 3 has greatest diameter. Abutting bearing area 10 is a cut groove 11 with a boxlike cross-section. Adjacent to the groove 11 are teeth 12 like a pinion with teeth flanks parallel to the axis 2. The top end of the teeth 12 in turn abut a peripherally cut groove 13 that neighbors a bearing area 14. The bearing area 14 of the shaft 3 is also flush with the outside of the housing 1 like bearing area 10. On the top end of the shaft 3 in Fig. 1 is a conventional dihedron 15.

[00014] The pistons 4 and 5 as represented in Fig. 1 are cut where they engage with the shaft 3. At this area, the pistons 4 and 5 have outwardly projecting teeth 20 like a pinion that mesh with the teeth 12 of the shaft 3. The axial edges of the teeth 20 each abut a segment 21 that is formed as a single piece with the pistons 4 and 5, and that engages in the grooves 11 and 13. The housing 1 has a through hole that runs in the direction of the axis 2 and that vertically intersects the middle of the midaxis of the cylinder 6. This hole forms bearing sites 22 that, together with bearing sites 10 and 14 of the shaft 3, form a friction bearing to rotate the shaft around the axis 2. In the area of the bearing sites 22, the interior of the cylinder 6 is sealed from the atmosphere with sealants (not shown) such as O-rings.

[00015] Fig. 2 shows the actuator from Fig. 1 in a cross-section along the axis of the cylinder 6. The axis 2 of the shaft 3 is perpendicular to the plane of projection in the drawing in Fig. 2. The same components have the same reference numbers.

[00016] Fig. 2 illustrates how the pistons 4 and 5 symmetrically surround the shaft 3. The pistons 4 and 5 bear sealing piston heads 30 that interact with the cylinder 6 and that abut the pinion-like area with the teeth 20. Plate-like cylinder heads 31 seal the housing 1 at the faces of

the cylindrical hole 6. The pistons 4, 5, the cylindrical hole 6 and the cylinder heads 31 thereby delimit a total of three working areas 32, 33 and 34 of which working areas 32 and 34 have a pneumatic parallel connection, and working area 33 can independently receive pressure. Corresponding connection holes for working areas 32, 33 and 34 are identified with reference numbers 35, 36 and 37.

[00017] In practice, the actuator under consideration is mounted by first inserting the shaft 3 along the direction of the axis 2 into the housing 1, or more precisely, into the through hole with the bearing sites 22 until the position in Fig. 1 is reached. Then proceeding from the open ends of the cylindrical hole 6, a piston is inserted on each side of the shaft 3 so that the teeth 20 engage with the teeth 12. At the same time, the segments 21 that run parallel to the teeth 12 engage in the grooves 11, 13. The pistons 4, 5 are then pressed symmetrically into the hole 6. This rotates the shaft 3 on its axis 2, the teeth 12 and 20 engage with each other, and the segments 21 slide in the grooves 11, 13. The positive engagement of segments 21 in the grooves 11, 13 fixes the shaft in the direction of the axis 2 without additional fasteners being required.

The cylinder 6 is sealed with the cylinder heads 31 and provided with the required pneumatic connections.

[00018] When the actuator is used, working area 33 (for example) is supplied with pressure so that the pistons 4 and 5 are pushed apart. In the drawing in Fig. 2, this causes the shaft 3 to rotate counterclockwise while the working areas 32 and 34 are vented. As would be understood by those having ordinary skill in the art, for the shaft 3 to rotate clockwise, the working areas 32 and 34 are supplied with pressure while working areas 33 is vented.

[00019] It is preferable for the grooves as portrayed in this exemplary embodiment to abut the side of the teeth 12, and for the pistons 4 and 5 to each have two segments 21. The outer edge of the segments 21 slides to contact the outer walls of the grooves 11, 13 during operation, while the segments 21 are at a slight distance from the teeth 12. The shaft 3 is only guided axially during operation by the flanks of the pistons.

[00020] In the present case, the preferred materials for an actuator according to the invention are aluminum for the housing 1 and the shaft 3, and plastic for the pistons 4 and 5. The seal at the bearing sites can be attained by self lubricating plastics. Other materials or combinations of materials are equally conceivable, however. The bearing only receives a small amount of stress during operation since it is an actuator as used for actuating valves.

[00021] The foregoing description merely explains and illustrates the invention and the invention is not limited thereto except insofar as the appended claims are so limited, as those skilled in the art who have the disclosure before them will be able to make modifications without  
5 departing from the scope of the invention.

## ABSTRACT

[00022] A pneumatic actuator having a pneumatic cylinder. At least one piston is movably positioned within the cylinder. The piston includes teeth which extend in the  
5 longitudinal direction of the cylinder. The teeth engage with teeth of a rotatable shaft which rotates perpendicular to the axis of the cylinder.

**TITLE OF THE INVENTION****SHAFT MOUNTING****BACKGROUND OF THE INVENTION****1. Field of the Invention**

The present invention [concerns] is directed to a pneumatic actuator [with the features of the preamble of claim 1].

**2. Background Art**

[Such an actuator is] Pneumatic actuators are known in the prior art [from] such as, for example German utility model G9014487.2. In prior-art actuators, the drive shaft is mounted in the housing with two end brackets. The end brackets are inserted into the housing from the inside that forms the cylinder, and the shaft is also fixed in an axial direction from the inside with exterior lock washers or snap rings. Installing the bearing and the lock washers from the work area of the cylinder is a rather difficult manual job which gives rise to undesirable costs.

It is therefore [the problem] an object of the present invention to improve a pneumatic actuator so that the shaft and pistons can be more easily installed in the housing with fewer required parts.

[This problem is solved with an actuator that has the features of claim 1.]

## **SUMMARY OF THE INVENTION**

Since the invention provides that the piston fixes the shaft in its axial direction by means of a keyed fit, the shaft can move axially until the piston is inserted and hence be moved into its position without additional fasteners. As soon as the piston is inserted, the positive engagement fixes the shaft axially which is brought about in the state of the art by means of [the] an end bracket and snap rings.

A particularly simple embodiment results when the shaft has at least one peripheral groove that engages with a segment of the piston running in an axial direction. When the shaft also has two bearing [areas] sites that form the areas where the shaft has the largest diameter, the shaft can be easily guided from the outside into the housing and fits [and] in the area of the bearing sites. Separate bearings are essentially dispensable when the shaft is mounted directly in the housing at two bearing sites. The shaft is mounted with minimal force when the bearing sites of the shaft essentially have the same diameter and thereby eliminate pressure in both directions. This also increases the length of time the shaft remains fixed at the segments and grooves.

It is particularly easy to create the groove when manufacturing the shaft when the groove is a peripherally cut groove. A symmetrical arrangement that allows the use of two identical piston results when each piston has two segments neighboring the teeth. In addition, the working area at the bearing sites of the shaft can also be sealed from the exterior by means of sealing rings made of rubber or plastic lying in a shaft groove.

A particularly advantageous method to mount the described actuator results when the shaft is first inserted into the bearing sites and then the piston(s) is engage[s]ed with the shaft so that the shaft is fixed in an axial direction without additional fasteners and, in particular, is held in the bearing sites.

# **BRIEF DESCRIPTION OF THE DRAWINGS**

An exemplary embodiment of the present invention will be described [in the following] with reference to the following drawings[.] , wherein

[Shown are:]

Fig. 1[: A] is a cross-section of an actuator according to the present invention following the axial direction of the shaft viewed in direction of the lengthwise axis of the cylinder; and

Fig. 2[: A] is a cross-section of an actuator following the lengthwise axis of the cylinder. The perspective coincides with the axial direction of the shaft.

## **DETAILED DESCRIPTION OF THE DRAWINGS**

Fig. 1 illustrates a pneumatic actuator according to the invention with a housing 1, a shaft 3 mounted in the housing that rotates around an axis of 2, and two pneumatic pistons 4 and 5. The inside of the housing 1 forms a cylindrical hole 6 in which the pistons 4 and 5 are inserted to form a sealed working area. The lengthwise axis of the hole 6 is perpendicular to the plane of projection.

The shaft 3 is essentially rotational symmetrical and has the following sections from bottom to top in Fig. 1:

The bottom end of the shaft forms a bearing area 10 that also represents the site where the shaft 3 has greatest diameter. Abutting bearing area 10 is a cut groove 11 with a boxlike cross-section. Adjacent to the groove 11 are teeth 12 like a pinion with teeth flanks parallel to the axis 2. The top end of the teeth 12 in turn abut a peripherally cut groove 13 that neighbors a bearing area 14. The bearing area 14 of the shaft 3 is also flush with the outside of the housing 1 like bearing area 10. On the top end of the shaft 3 in Fig. 1 is a conventional dihedron 15.

The pistons 4 and 5 as represented in Fig. 1 are cut where they engage with the shaft 3. At this area, the pistons 4 and 5 have outwardly projecting teeth 20 like a pinion that mesh with the teeth 12 of the shaft 3. The axial edges of the teeth 20 each abut a segment 21 that is formed as a single piece with the pistons 4 and 5, and that engages in the grooves 11 and 13. The housing 1 has a through hole that runs in the direction of the axis 2 and that vertically intersects the middle of the midaxis of the cylinder 6. This hole forms bearing sites 22 that, together with bearing sites 10 and 14 of the shaft 3, form a friction bearing to rotate the shaft around the axis 2. In the area of the bearing sites 22, the interior of the cylinder 6 is sealed from the atmosphere with sealants (not shown) such as O-rings.

Fig. 2 shows the actuator from Fig. 1 in a cross-section along the axis of the cylinder 6. The axis 2 of the shaft 3 is perpendicular to the plane of projection in the drawing in Fig. 2. The same components have the same reference numbers.

Fig. 2 illustrates how the pistons 4 and 5 symmetrically surround the shaft 3. The pistons 4 and 5 bear sealing piston heads 30 that interact with the cylinder 6 and that abut the pinion-like area with the teeth 20. Plate-like cylinder heads 31 seal the housing 1 at the faces of the cylindrical hole 6. The pistons 4, 5, the cylindrical hole 6 and the cylinder heads 31 thereby



delimit a total of three working areas 32, 33 and 34 of which working areas 32 and 34 have a pneumatic parallel connection, and working area 33 can independently receive pressure. Corresponding connection holes for working areas 32, 33 and 34 are identified with reference numbers 35, 36 and 37.

In practice, the actuator under consideration is mounted by first inserting the shaft 3 along the direction of the axis 2 into the housing 1, or more precisely, into the through hole with the bearing sites 22 until the position in Fig. 1 is reached. Then proceeding from the open ends of the cylindrical hole 6, a piston is inserted on each side of the shaft 3 so that the teeth 20 engage with the teeth 12. At the same time, the segments 21 that run parallel to the teeth 12 engage in the grooves 11, 13. The pistons 4, 5 are then pressed symmetrically into the hole 6. This rotates the shaft 3 on its axis 2, the teeth 12 and 20 engage with each other, and the segments 21 slide in the grooves 11, 13. The positive engagement of segments 21 in the grooves 11, 13 fixes the shaft in the direction of the axis 2 without additional fasteners being required. The cylinder 6 is sealed with the cylinder heads 31 and provided with the required pneumatic connections.

When the actuator is used, working area 33 (for example) is supplied with pressure so that the pistons 4 and 5 are pushed apart. In the drawing in Fig. 2, this causes the shaft 3 to rotate counterclockwise while the working areas 32 and 34 are vented. [For] As would be understood by these having ordinary skill in the art, the shaft 3 to rotate clockwise, the working areas 32 and 34 are supplied with pressure while working areas 33 is vented. [This method is known from the state-of-the-art.]

It is preferable for the grooves as portrayed in this exemplary embodiment to abut the side of the teeth 12, and for the pistons 4 and 5 to each have two segments 21. The outer edge of the segments 21 slides to contact the outer walls of the grooves 11, 13 during operation, while the segments 21 are at a slight distance from the teeth 12. The shaft 3 is only guided axially during operation by the flanks of the pistons.

In the present case, the preferred materials for an actuator according to the invention are aluminum for the housing 1 and the shaft 3, and plastic for the pistons 4 and 5. The seal at the bearing sites can be attained by self lubricating plastics. Other materials or combinations of materials are equally conceivable, however. The bearing only receives a small amount of stress during operation since it is an actuator as used for actuating valves.

The foregoing description merely explains and illustrates the invention and the invention is not limited thereto except insofar as the appended claims are so limited, as those skilled in the art who have the disclosure before them will be able to make modifications without departing from the scope of the invention.

**ABSTRACT**

A pneumatic actuator having a pneumatic cylinder. At lease one piston is movable positioned within the cylinder. The piston includes teeth which extend in the longitudinal direction of the cylinder. The teeth engage with teeth of a rotatable shaft which rotates perpendicular to the axis of the cylinder.

**TITLE OF THE INVENTION**

SHAFT MOUNTING

**5 BACKGROUND OF THE INVENTION**

## 1. Field of the Invention

[00001] The present invention is directed to a pneumatic actuator.

## 10 2. Background Art

[00002] Pneumatic actuators are known in the prior art such as, for example, German utility model G9014487.2. In prior-art actuators, the drive shaft is mounted in the housing with two end brackets. The end brackets are inserted into the housing from the inside that forms the cylinder, and the shaft is also fixed in an axial direction from the inside with exterior lock

15 washers or snap rings. Installing the bearing and the lock washers from the work area of the cylinder is a rather difficult manual job which gives rise to undesirable costs.

[00003] It is therefore an object of the present invention to improve a pneumatic actuator so that the shaft and pistons can be more easily installed in the housing with fewer required parts.

20

2/prb

**Shaft Mounting**

The present invention concerns a pneumatic actuator with the features of the preamble of claim 1.

Such an actuator is prior art from German utility model G9014487.2. In prior-art actuators, the drive shaft is mounted in the housing with two end brackets. The end brackets are inserted into the housing from the inside that forms the cylinder, and the shaft is also fixed in an axial direction from the inside with exterior lock washers or snap rings. Installing the bearing and the lock washers from the work area of the cylinder is a rather difficult manual job which gives rise to undesirable costs.

It is therefore the problem of the present invention to improve a pneumatic actuator so that the shaft and pistons can be more easily installed in the housing with fewer required parts.

This problem is solved with an actuator that has the features of claim 1.

Since the invention provides that the piston fixes the shaft in its axial direction by means of a keyed fit, the shaft can move axially until the piston is inserted and hence be moved into its position without additional fasteners. As soon as the piston is inserted, the positive engagement fixes the shaft axially which is brought about in the state of the art by means of the end bracket and snap rings.

A particularly simple embodiment results when the shaft has at least one peripheral groove that engages with a segment of the piston running in an axial direction. When the shaft also has two bearing areas that form the areas where the shaft has the largest diameter, the shaft can be easily guided from the outside into the housing and fits in the area of the bearing sites. Separate bearings are essentially dispensable when the shaft is mounted directly in the housing at two bearing sites. The shaft is mounted with minimal force when the bearing sites of the shaft essentially have the same diameter and thereby

eliminate pressure in both directions. This also increases the length of time the shaft remains fixed at the segments and grooves.

It is particularly easy to create the groove when manufacturing the shaft when the groove is a peripherally cut groove. A symmetrical arrangement that allows the use of two identical piston results when each piston has two segments neighboring the teeth. In addition, the working area at the bearing sites of the shaft can also be sealed from the exterior by means of sealing rings made of rubber or plastic lying in a shaft groove.

A particularly advantageous method to mount the described actuator results when the shaft is first inserted into the bearing sites and then the piston(s) is engages with the shaft so that the shaft is fixed in an axial direction without additional fasteners and, in particular, is held in the bearing sites.

An exemplary embodiment of the present invention will be described in the following with reference to drawings.

Shown are:

Fig. 1: A cross-section of an actuator according to the invention following the axial direction of the shaft viewed in direction of the lengthwise axis of the cylinder; and

Fig. 2: A cross-section of an actuator following the lengthwise axis of the cylinder. The perspective coincides with the axial direction of the shaft.

Fig. 1 illustrates a pneumatic actuator according to the invention with a housing 1, a shaft 3 mounted in the housing that rotates around an axis of 2, and two pneumatic pistons 4 and 5. The inside of the housing 1 forms a cylindrical hole 6 in which the pistons 4 and 5 are inserted to form a sealed working area. The lengthwise axis of the hole 6 is perpendicular to plane of projection.

The shaft 3 is essentially rotational symmetrical and has the following sections from bottom to top in Fig. 1:

The bottom end of the shaft forms a bearing area 10 that also represents the site where the shaft 3 has greatest diameter. Abutting bearing area 10 is a cut groove 11 with a boxlike cross-section. Adjacent to the groove 11 are teeth 12 like a pinion with teeth flanks parallel to the axis 2. The top end of the teeth 12 in turn abut a peripherally cut groove 13 that neighbors a bearing area 14. The bearing area 14 of the shaft 3 is also flush with the outside of the housing 1 like bearing area 10. On the top end of the shaft 3 in Fig. 1 is a conventional dihedron 15.

The pistons 4 and 5 as represented in Fig. 1 are cut where they engage with the shaft 3. At this area, the pistons 4 and 5 have outwardly projecting teeth 20 like a pinion that mesh with the teeth 12 of the shaft 3. The axial edges of the teeth 20 each abut a segment 21 that is formed as a single piece with the pistons 4 and 5, and that engages in the grooves 11 and 13. The housing 1 has a through hole that runs in the direction of the axis 2 and that vertically intersects the middle of the midaxis of the cylinder 6. This hole forms bearing sites 22 that, together with bearing sites 10 and 14 of the shaft 3, form a friction bearing to rotate the shaft around the axis 2. In the area of the bearing sites 22, the interior of the cylinder 6 is sealed from the atmosphere with sealants (not shown) such as O-rings.

Fig. 2 shows the actuator from Fig. 1 in a cross-section along the axis of the cylinder 6. The axis 2 of the shaft 3 is perpendicular to the plane of projection in the drawing in Fig. 2. The same components have the same reference numbers.

Fig. 2 illustrates how the pistons 4 and 5 symmetrically surround the shaft 3. The pistons 4 and 5 bear sealing piston heads 30 that interact with the cylinder 6 and that abut the pinion-like area with the teeth 20. Plate-like cylinder heads 31 seal the housing 1 at the faces of the cylindrical hole 6. The pistons 4, 5, the cylindrical hole 6 and the cylinder

heads 31 thereby delimit a total of three working areas 32, 33 and 34 of which working areas 32 and 34 have a pneumatic parallel connection, and working area 33 can independently receive pressure. Corresponding connection holes for working areas 32, 33 and 34 are identified with reference numbers 35, 36 and 37.

In practice, the actuator under consideration is mounted by first inserting the shaft 3 along the direction of the axis 2 into the housing 1, or more precisely, into the through hole with the bearing sites 22 until the position in Fig. 1 is reached. Then proceeding from the open ends of the cylindrical hole 6, a piston is inserted on each side of the shaft 3 so that the teeth 20 engage with the teeth 12. At the same time, the segments 21 that run parallel to the teeth 12 engage in the grooves 11, 13. The pistons 4, 5 are then pressed symmetrically into the hole 6. This rotates the shaft 3 on its axis 2, the teeth 12 and 20 engage with each other, and the segments 21 slide in the grooves 11, 13. The positive engagement of segments 21 in the grooves 11, 13 fixes the shaft in the direction of the axis 2 without additional fasteners being required. The cylinder 6 is sealed with the cylinder heads 31 and provided with the required pneumatic connections.

When the actuator is used, working area 33 (for example) is supplied with pressure so that the pistons 4 and 5 are pushed apart. In the drawing in Fig. 2, this causes the shaft 3 to rotate counterclockwise while the working areas 32 and 34 are vented. For the shaft 3 to rotate clockwise, the working areas 32 and 34 are supplied with pressure while working areas 33 is vented. This method is known from the state-of-the-art.

It is preferable for the grooves as portrayed in this exemplary embodiment to abut the side of the teeth 12, and for the pistons 4 and 5 to each have two segments 21. The outer edge of the segments 21 slides to contact the outer walls of the grooves 11, 13 during operation, while the segments 21 are at a slight distance from the teeth 12. The shaft 3 is only guided axially during operation by the flanks of the pistons.

In the present case, the preferred materials for an actuator according to the invention are aluminum for the housing 1 and the shaft 3, and plastic for the pistons 4 and 5. The seal



at the bearing sites can be attained by self lubricating plastics. Other materials or combinations of materials are equally conceivable, however. The bearing only receives a small amount of stress during operation since it is an actuator as used for actuating valves.

### Patent Claims

1. Pneumatic actuator comprising a housing (1) which has a pneumatic cylinder (6), and comprising at least one piston (4, 5) that can move inside the cylinder (6) in the direction of the axis of the cylinder (6) and, together with the cylinder (6), delimits a working space (32, 33, 34), whereby the piston (4, 5) has teeth (20) which extend in the direction of the axis, and comprising a shaft (3) which can rotate in an axial direction (2) whose axial direction (2) is perpendicular to the axis, and which has teeth (12) that engages with the teeth (20) of the piston (4, 5), **characterized in that** the piston (4,5) fixes the shaft (3) in its axial direction (2) by means of positive engagement.
2. Actuator according to claim 1, **characterized in that** the shaft (3) has at least one peripheral groove (11, 13) that engages with a segment (21) of the piston (4,5) running in the axial direction.
3. Actuator according to one of the prior claims, **characterized in that** the shaft (3) has two bearing areas (10, 14) that form the areas where the shaft (3) has the greatest diameter.
4. Actuator according to one of the prior claims, **characterized in that** the shaft (3) is mounted directly in the housing (1) at two bearing sites (22).
5. Actuator according to one of the prior claims, **characterized in that** the bearing sites (10, 14) of the shaft of (3) essentially have the same diameter.
6. Actuator according to one of the prior claims, **characterized in that** the groove (11, 13) is a peripherally cut groove.
7. Actuator according to one of the prior claims, **characterized in that** each piston (4,5) has a total of two of the segments (21) neighboring the teeth (20).

8. Actuator according to one of the prior claims, **characterized in that** the pistons (4,5) are made of plastic.
9. Actuator according to one of the prior claims, **characterized in that** the working area (33) in the area of the bearing sites (11, 14) of the shaft (3) is sealed from the exterior by means of sealing rings that are placed in a groove of the shaft (3).
10. Method to mount an actuator according to one of the prior claims, **characterized in that** first the shaft (3) is inserted in the bearing sites (22), and then the piston(s) (4,5) engage with the shaft (3).
11. Method according to claims 10, **characterized in that** the shaft (3) is held in the bearing sites (22) without additional fasteners.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES  
PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum  
Internationales Büro



(43) Internationales Veröffentlichungsdatum  
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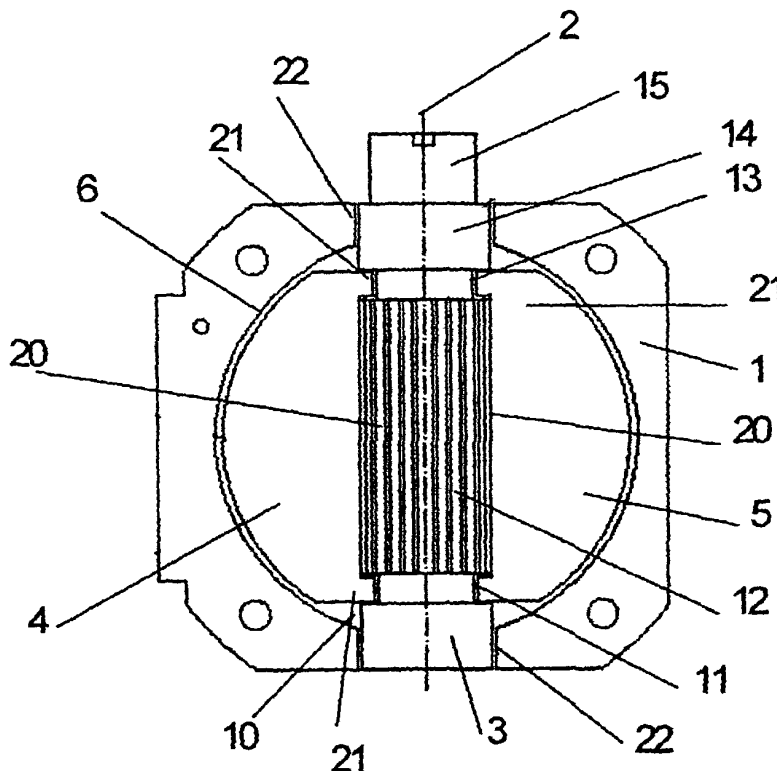
(10) Internationale Veröffentlichungsnummer  
**WO 01/14751 A1**

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- (21) Internationales Aktenzeichen: PCT/EP00/08191
- (22) Internationales Anmeldedatum: 22. August 2000 (22.08.2000) (72) **Erfinder; und**  
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- (30) Angaben zur Priorität: 199 40 644.8 ✓ 26. August 1999 (26.08.1999) DE (81) **Bestimmungsstaaten (national)**: AU, IN, US.

[Fortsetzung auf der nächsten Seite]

(54) Title: SHAFT MOUNTING

(54) Bezeichnung: WELLENLAGERUNG



(57) Abstract: The invention relates to a pneumatic actuator comprising a housing (1), which has a pneumatic cylinder (6), and comprising at least one piston (4, 5). Said piston can move inside the cylinder (6) in the direction of the axis of the cylinder (6) and, together with the cylinder (6), delimits a working space (32, 33, 34). The piston (4, 5) has a gearing (20) which extends in a direction of the axis. The inventive pneumatic actuator also comprises a shaft (3) which can rotate around an axial direction (2), whose axial direction (2) is vertical in relation to the axis, and which has a gearing (12) that engages with the gearing (20) of the piston (4, 5). A less complex structure is obtained by virtue of the fact that the piston (4, 5) fixes the shaft (3) with positive engagement in the axial direction thereof (2).

[Fortsetzung auf der nächsten Seite]

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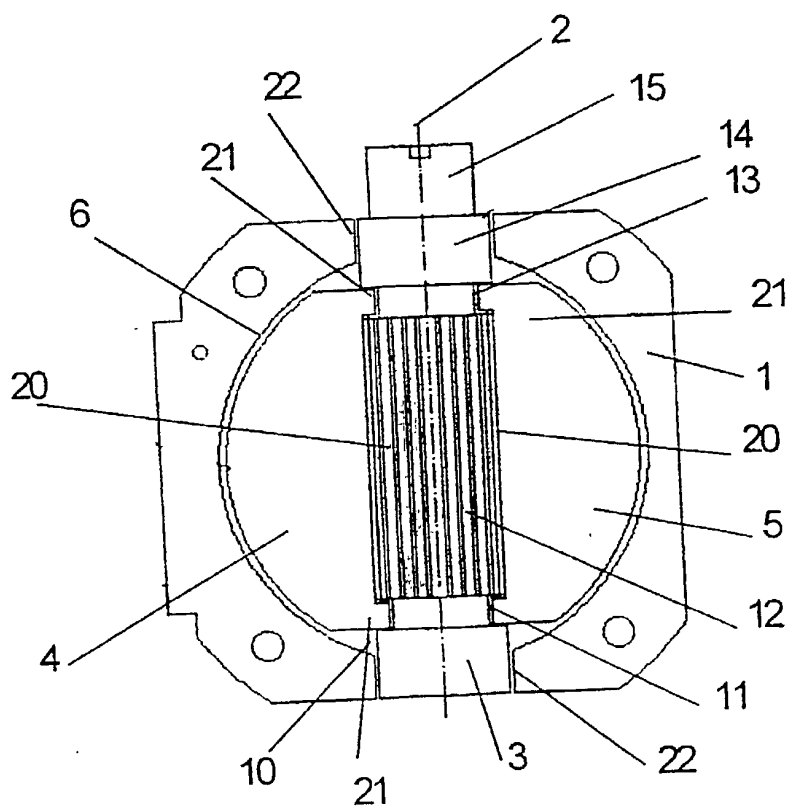


Fig. 1

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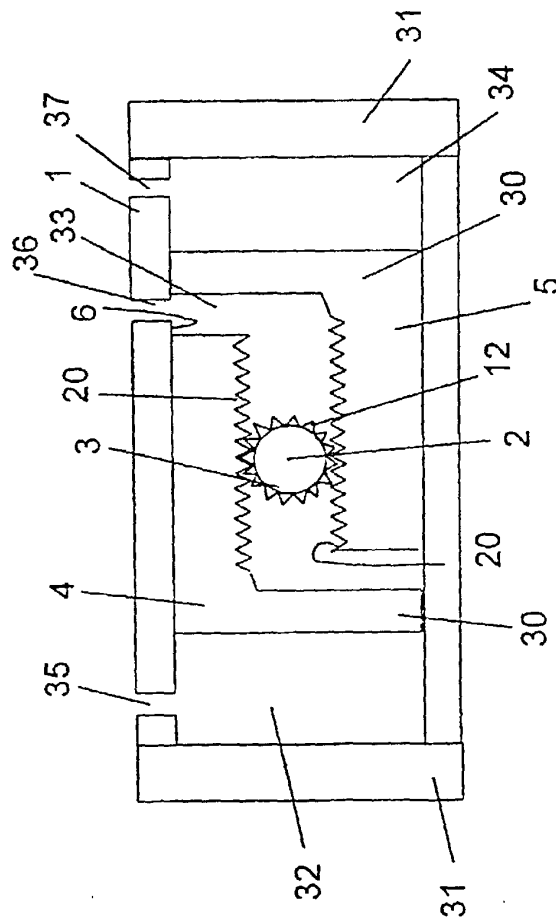


Fig. 2

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PTO/SB/01 (03-01)

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**DECLARATION FOR UTILITY OR  
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(37 CFR 1.63)**

☐ Declaration  
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☐ Declaration  
Submitted after Initial  
Filing (surcharge  
(37 CFR 1.19 (e))  
required)

Attorney Docket Number: LEN-021022

First Named Inventor: Hessler

**COMPLETE IF KNOWN**

Application Number: 10/069,830

Filing Date: 2/26/02

Group Art Unit

Examiner Name

As a below named inventor, I hereby declare that:

My residence, mailing address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

SHAFT MOUNTING

(Title of the Invention)

the specification of which

☒ is attached hereto

OR

☒

was filed on (MM/DD/YYYY)

08/22/2000

as United States Application Number or PCT International

Application Number: PCT/EP00/08191 and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?
19940844.8	Germany	8/28/1999	<input type="checkbox"/>	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO
PCT/EP00/08191	PCT	8/22/2000	<input type="checkbox"/>	<input type="checkbox"/> YES <input type="checkbox"/> NO
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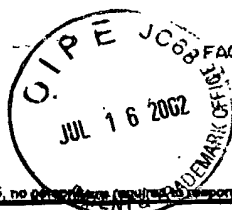
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NAME OF SOLE OR FIRST INVENTOR:		<input type="checkbox"/> A petition has been filed for this unsigned inventor		
Given Name (first and middle (if any)) <u>Peter</u>		Family Name or Surname <u>Hessing</u>		
Inventor's Signature <u>P. Hess</u>		Date <u>2.7.02, 2002</u>		
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Inventor's Signature		Date		
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<input type="checkbox"/> Additional inventors are being named on the supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.				

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